SELECT HYDROGRAPHIC SECTIONS FROM THE AGULHAS RESEARCH CRUISES OF THE RESEARCH VESSELS **KNORR** AND **MEIRING NAUDE** - 1983

by Arnold L. Gordon, Johann R. E. Lutjeharms and Marten L. Gründlingh

TECHNICAL REPORT

LDGO-87-1

Department of the Navy

Office of Naval Research

Contract N00014-84-C-0132 SC 00

Lamont-Doherty Geological Observatory

of Columbia University

Palisades, New York 10964

June 1987

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National Research Institute for Oceanology
CSIR, Stellenbosch 7600
South Africa

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Select Hydrographic Sections from the Agulhas Research Cruises of the Research Vessels KNORR and MEIRING NAUDE- 1983

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This report presents a series of hydrographic sections (figure 1) obtained During late 1983 from the R/V KNORR (November-December, 1983) and from the R/V MEIRING NAUDE (September-October, 1983) in the vinicity of the Agulhas Current and Agulhas Retroflection.

The KNORR hydrographic data report is presented by Camp et. al. 1986, and the XBT data is included in the report by Haines et. al. 1984. The scientific results from these cruises are reported by Gordon, 1985; Gründlingh, 1986; Lutjeharms and Gordon, 1987; and by Gordon, Lutjeharms and Gründlingh, 1987.

The latter paper presents a comprehensive discussion of the oceanography of the Agulhas Retroflection based on the data collected by the KNORR and MEIRING NAUDE. The abstract for the Gordon et. al. 1987 study is given below; the sections presented in this techical report provide additional information.

ABSTRACT

STRATIFICATION AND CIRCULATION AT THE AGULHAS RETROFLECTION

The Agulhas Retroflection, as observed in late 1983, consists of the main Retroflection at 21° E with two large warm core Agulhas rings to its west. The Retroflection position is situated at the eastern-most limit of its range. The ring immediately to the west (Retroflection Eddy) is elliptical in shape and carries 40 x 10^6 m^3/sec relative to the 1500 decibar (db) level; it's core properties are identical to the water enclosed by the Retroflection. These characteristics suggest that the Retroflection Eddy was formed just prior to the field work, thus the west edge of the Retroflection Eddy near 15° E marks the prior position of the main Retroflection, close to the western limit of its range,. The second eddy (Cape Town Eddy), centered about 250 km southwest of Cape Town, is circular in form, carries 35 x 10^6 m^3/sec relative to 1500 db. It encircles a core of Agulhas water which was highly altered, by the action of the winter atmosphere, from the source Agulhas water. The southwest transport into the main Retroflection through the Agulhas Passage, is 70 x 10^6 m^3/sec relative to 1500 db (95 x 10^6 m^3/sec relative to the sea floor). Most enters the Retroflection, but 10 x 10^6 m^3/sec (relative to 1500 db) continues into the South Atlantic within the region between the two eddies and the African mainland. The magnitude of this flow into the South Atlantic is increased somewhat by the inclusion of South Atlantic water. The Agulhas Return Current, which receives most of the Agulhas current transport, flows eastward near 40° S and then executes a "S"-shaped meander over the west half of the Agulhas Plateau to pass eastward within the southern side of the Agulhas Passage.

The Agulhas Current introduces Indian Ocean water masses into the Retroflection region, though this is limited to water less dense than sigma-0 of 27.5, shallower than 1500 or 2000 meters. At greater depth, the water flowing within the Retroflection circulation pattern consists primarily of Atlantic and circumpolar deep water. The Indian Ocean water entering the Retroflection is drawn from diverse sources: the thermocline of the South Indian subtropical gyre, the thermocline water

of the western tropical Indian Ocean and within the lower thermocline, remnants of the high salinity-low oxygen water from the Red Sea. Once in the Retroflection region the Indian Ocean water is altered by the local atmosphere (forming remnant winter mixed layers, marked by relatively high salinity and oxygen) and by low salinity intrusions of South Atlantic water.

Acknowledgements- The KNORR data was obtained through the funding of N000-14-84-C-0132. The MEIRING NAUDE data was obtained by the National Research Institute for Oceanology of CSIR in Stellenbosch, South Africa.

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Camp, D., W. Haines, B. Huber, S. Rennie, and A. Gordon, 1986 Agulhas Retroflection Cruise, November-December 1983. Lamont-Doherty Geol. Obs. Tech Report 86-1.

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Lutjeharms, J. R. E., and A. L. Gordon 1987 Shedding of an Agulhas Ring Observed at Sea. Nature 325(7000):138-140.

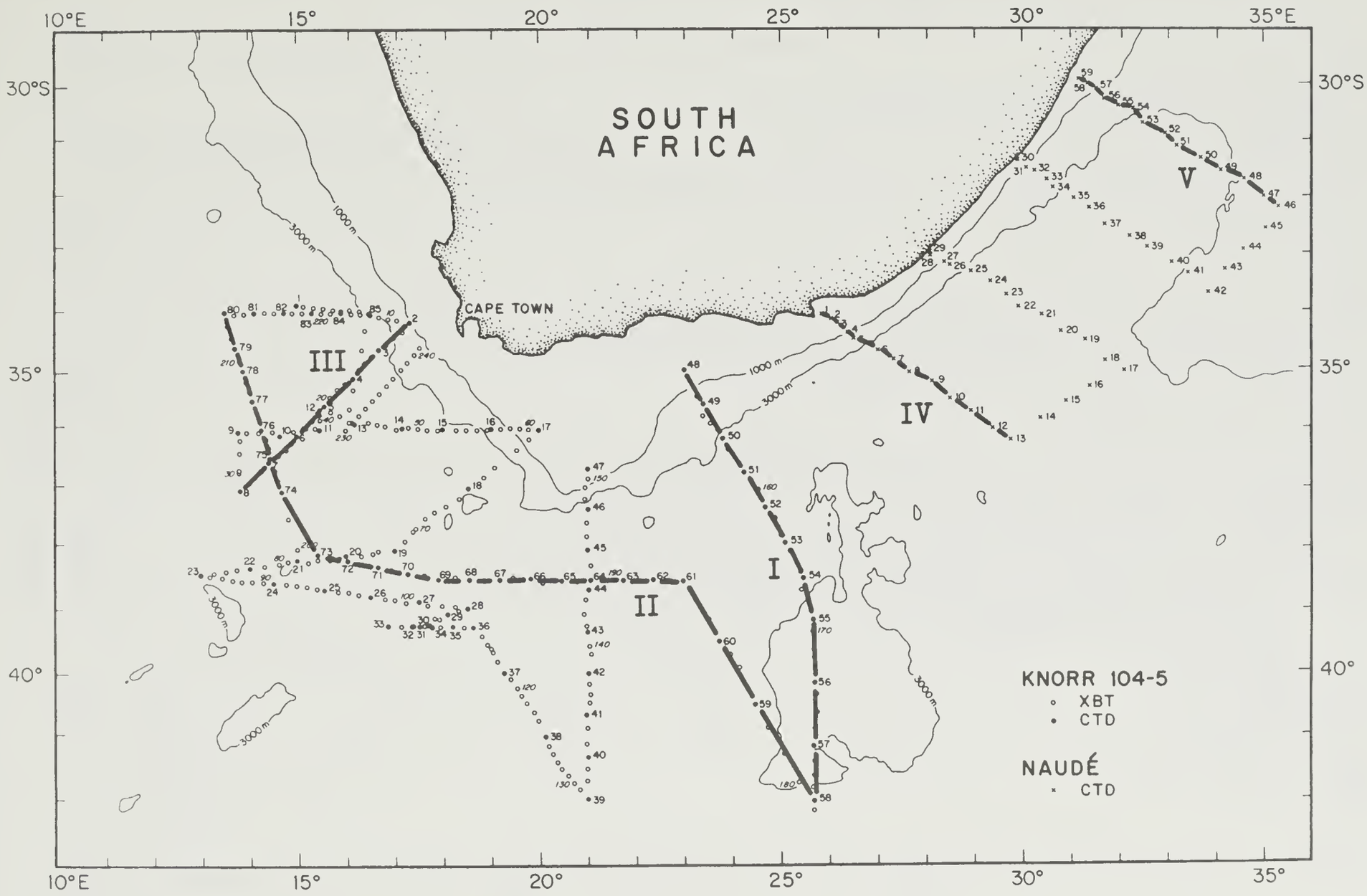
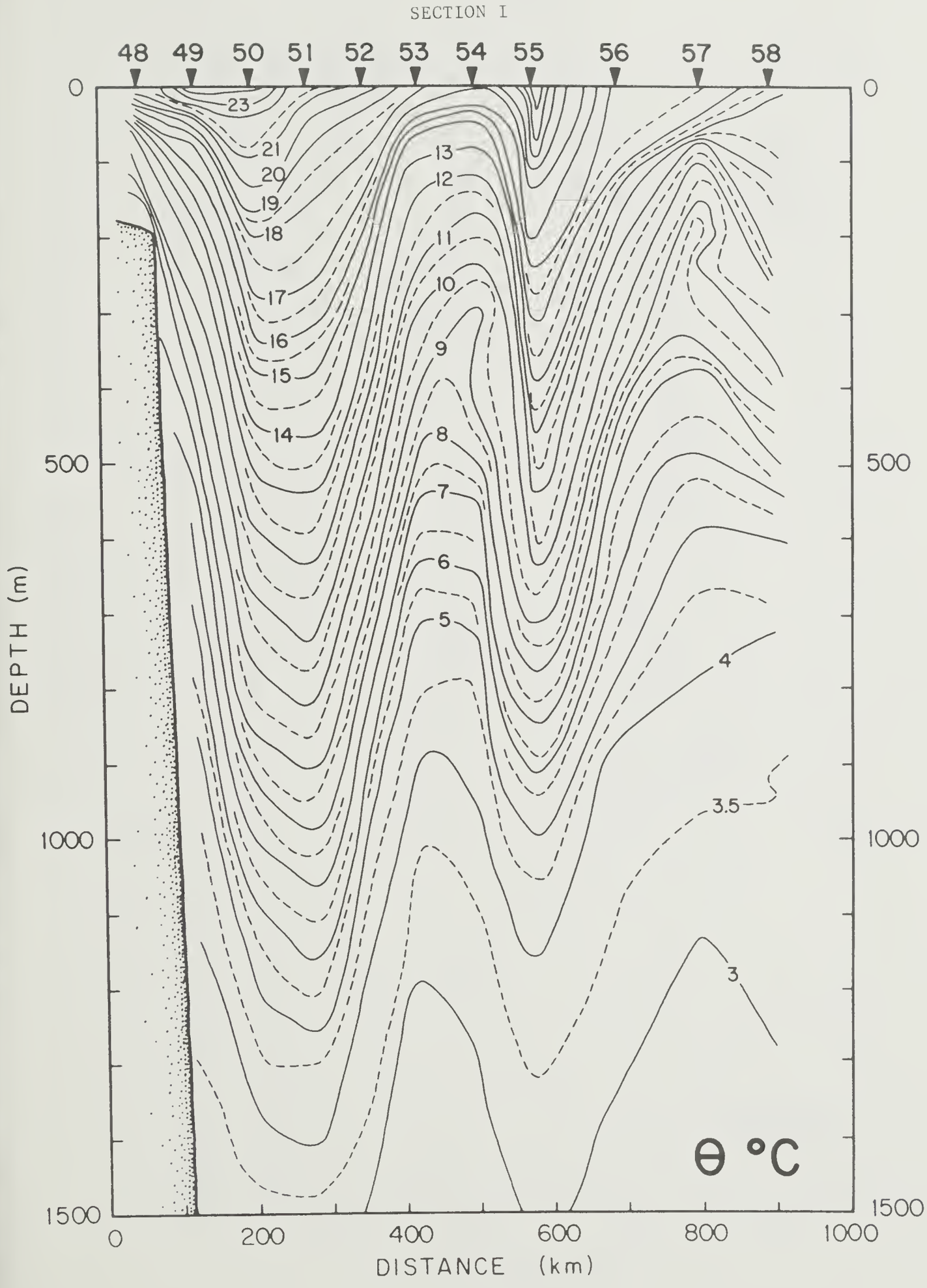

10°E
15°
20°
25°
30°
35°E
30°S
35°
40°
SOUTH
AFRICA
CAPE TOWN
1000 m
3000 m
I
II
III
IV
V
KNORR 104-5
XBT
CTD
NAUDÉ
CTD

Fig. 1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1500
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17
16
15
14
13
12
11
10
9
8
7
6
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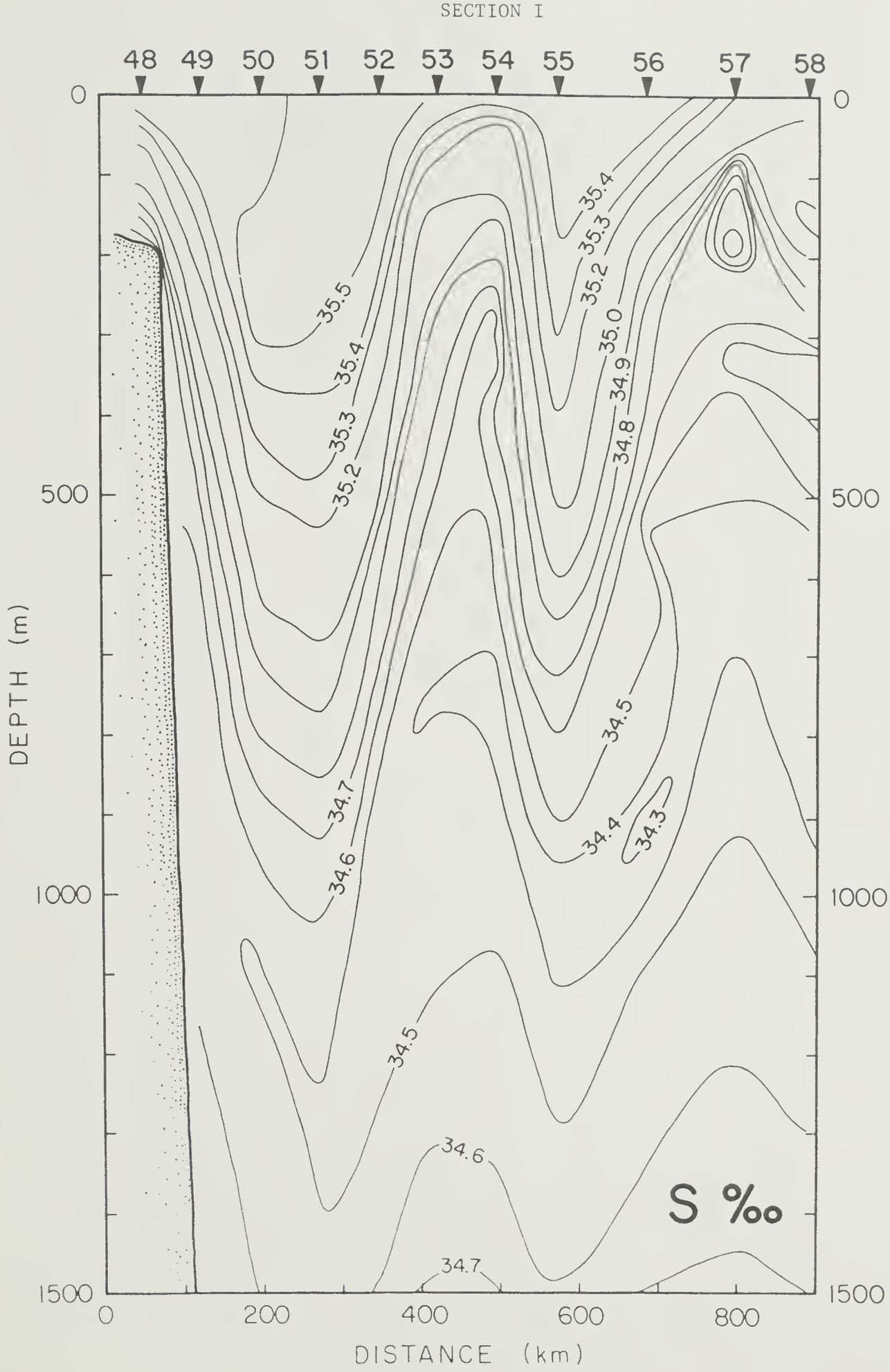
4
3.5
3
θ °C
DEPTH (m)
0
200
400
600
800
1000
DISTANCE (km)

Fig. 2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57
58
0
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1000
1500
DEPTH (m)
DISTANCE (km)
0
200
400
600
800
35.5
35.4
35.3
35.2
35.4
35.3
35.2
35.0
34.9
34.8
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34.7
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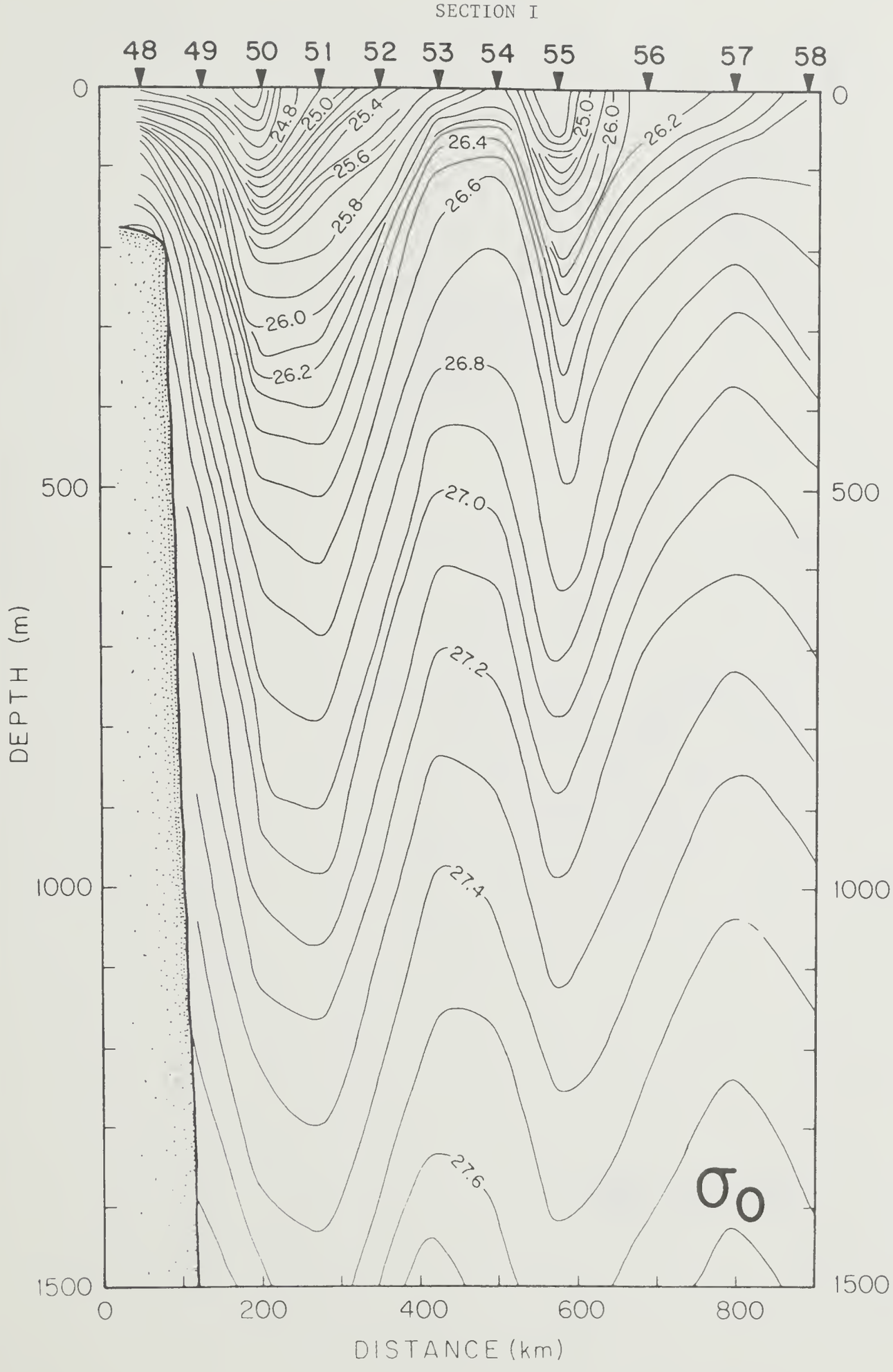
34.6
34.7
S ‰

Fig. 3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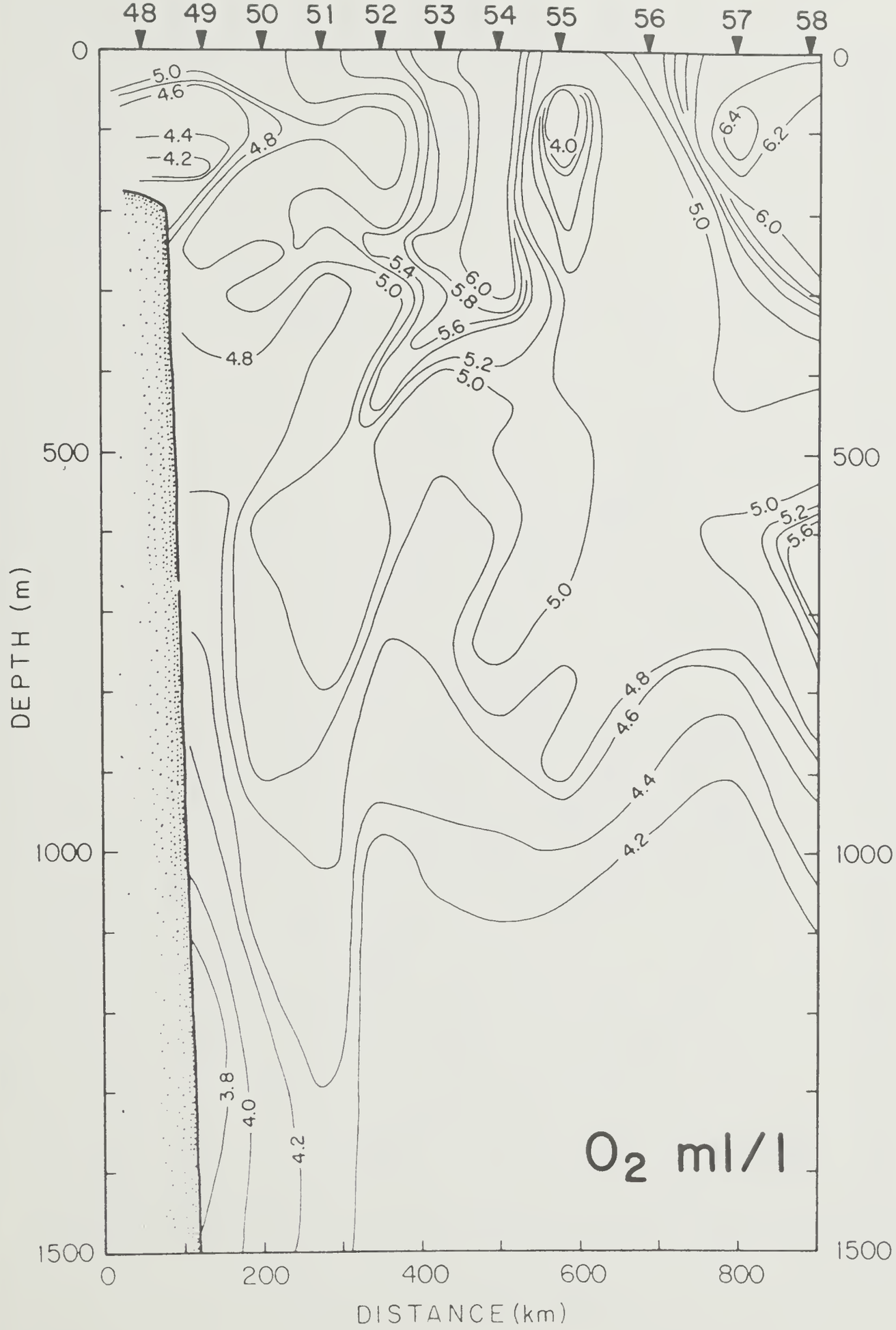
26.0
26.2
26.4
26.6
26.8
27.0
27.2
27.4
27.6
500
1000
1500
DEPTH (m)
0
200
400
600
800
DISTANCE (km)
σ0

Fig. 4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52
53
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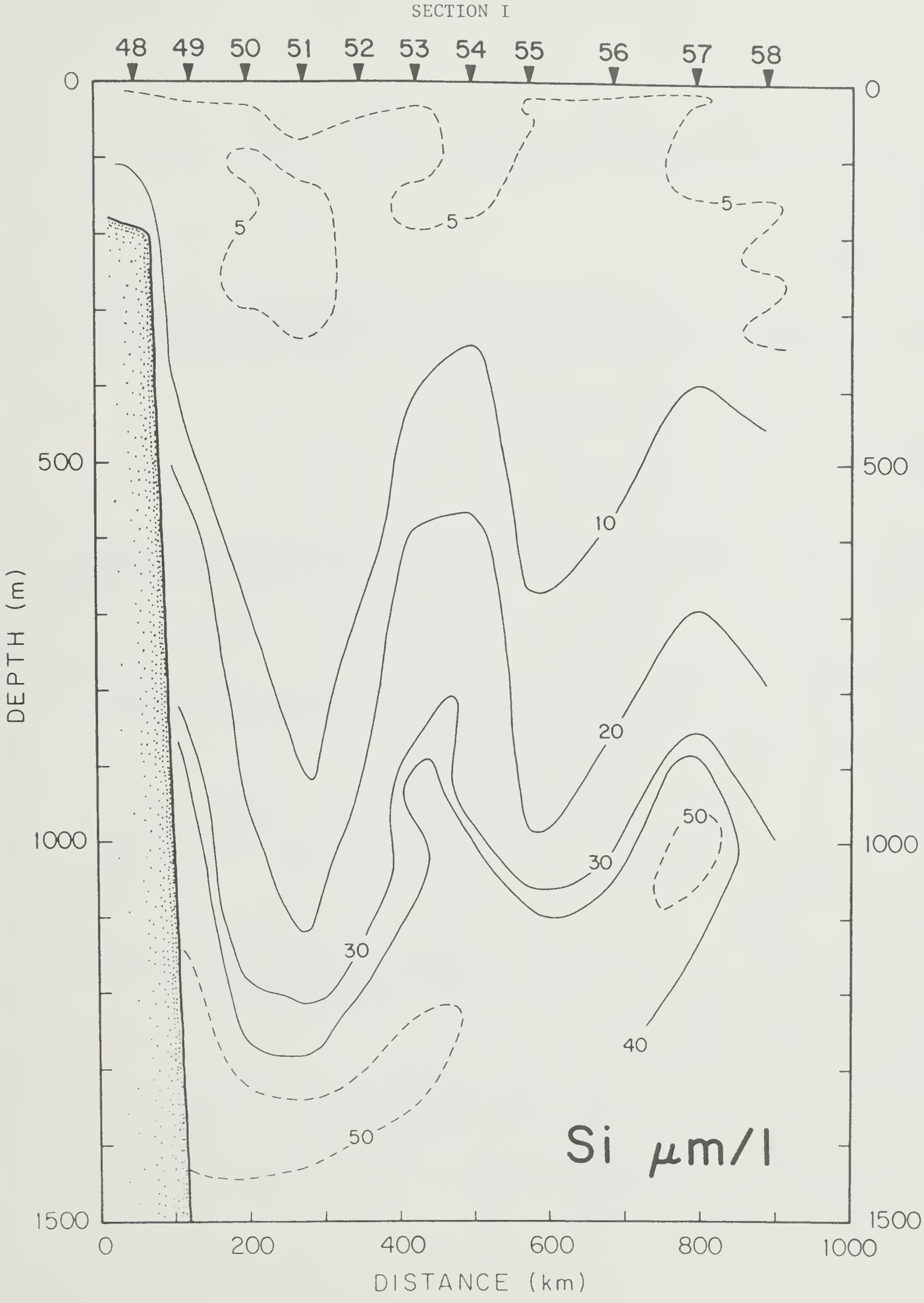
55
56
57
58
0
500
1000
1500
DEPTH (m)
DISTANCE (km)
0
200
400
600
800
5.0
4.6
4.4
4.2
4.8
4.0
6.4
6.2
6.0
5.4
5.8
5.6
5.2
3.8
O_2 ml/l

Fig. 5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58
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500
1000
1500
DEPTH (m)
5
5
5
10
20
30
30
40
50
50
Si µm/l
0
200
400
600
800
1000
DISTANCE (km)

Fig. 6

SECTION II

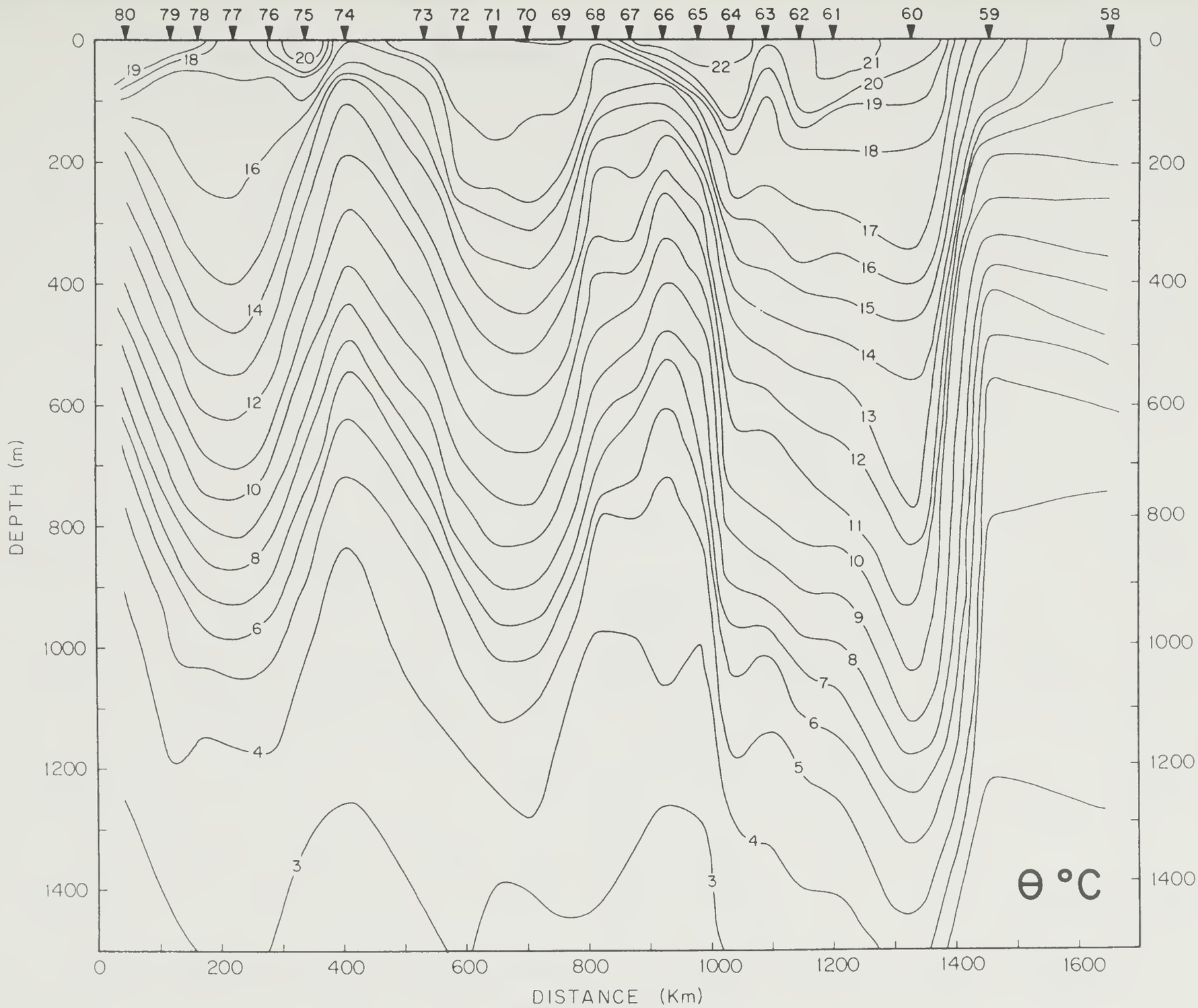

Fig. 7

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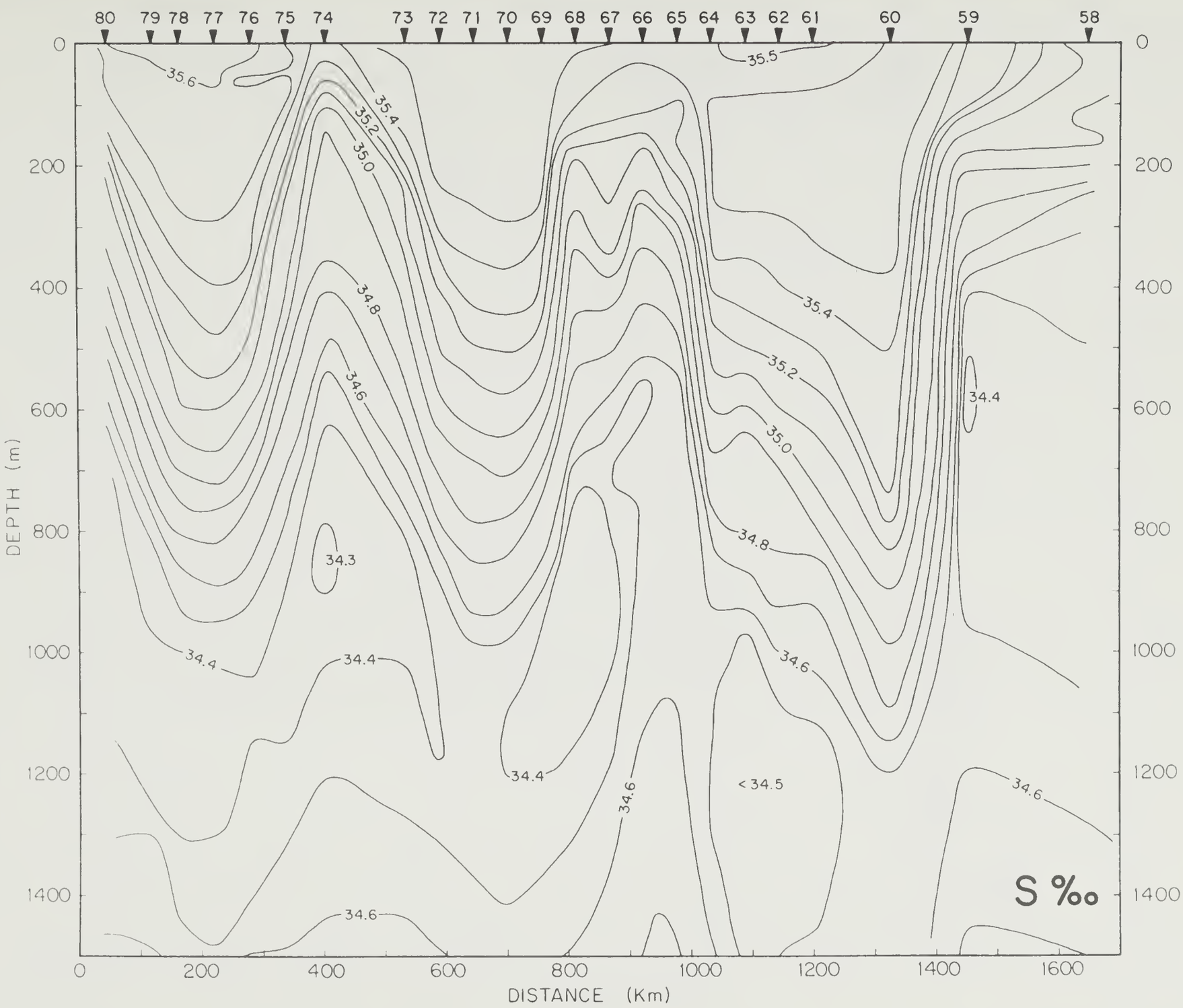

Fig. 8

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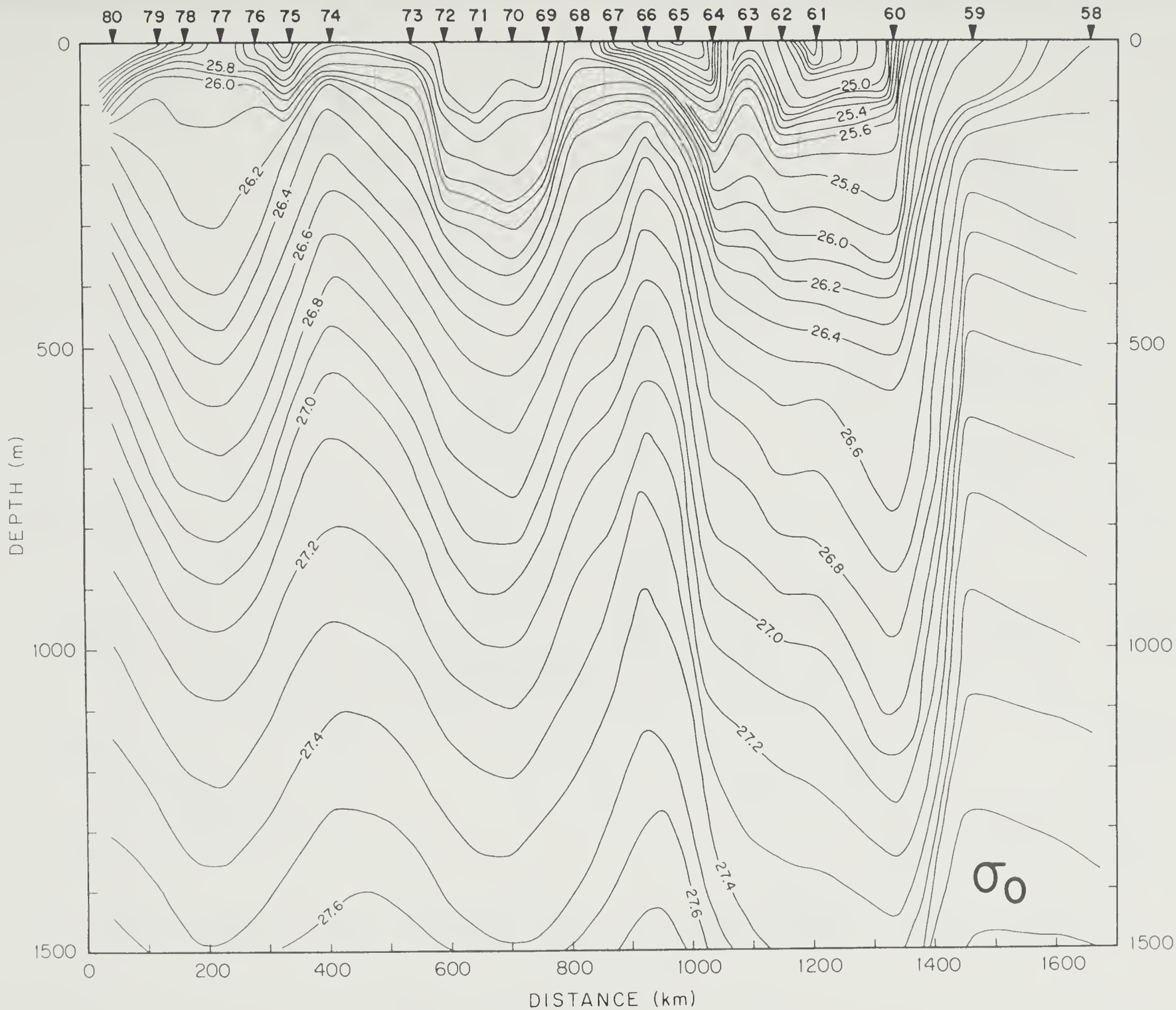

FIG. 9

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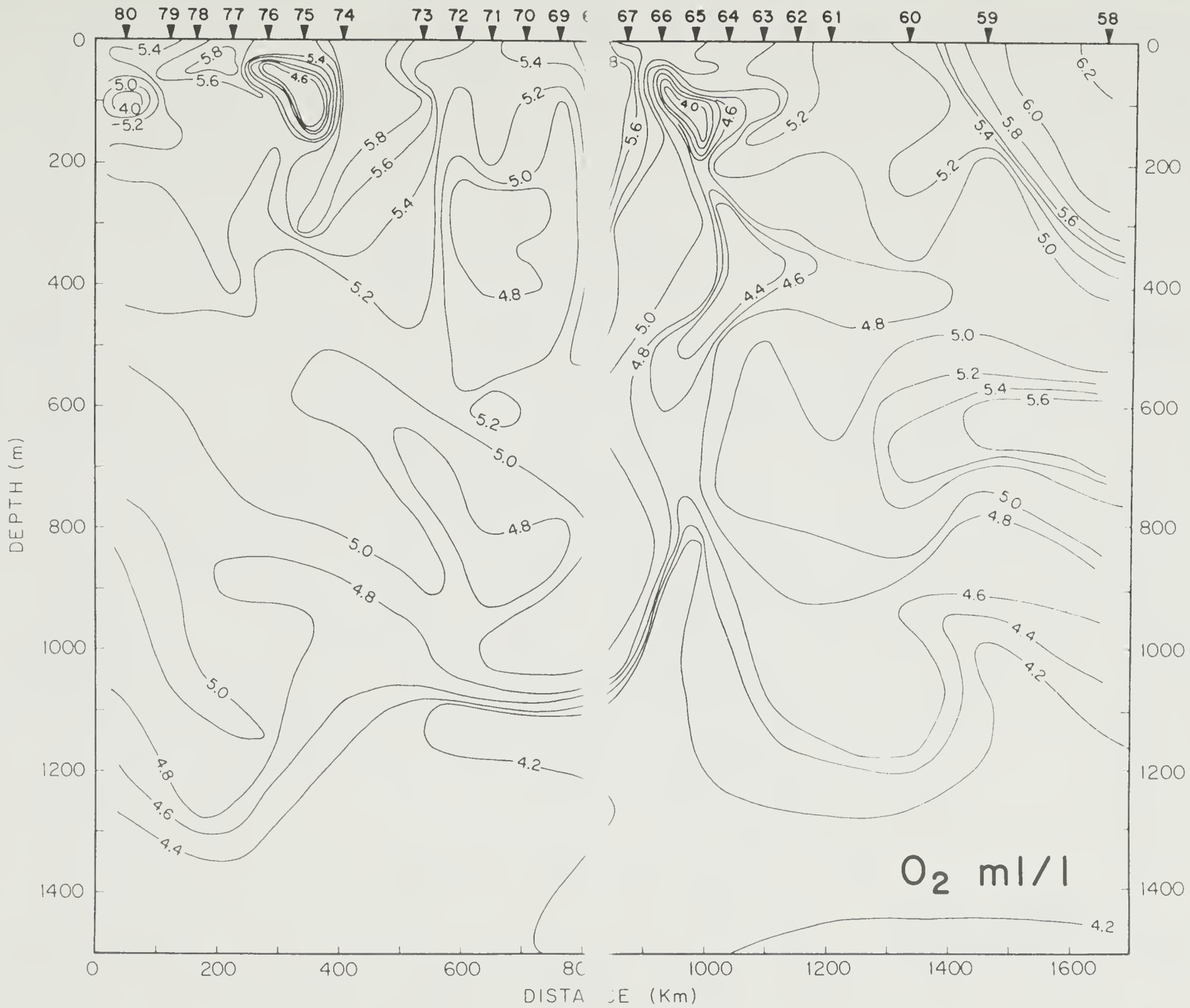

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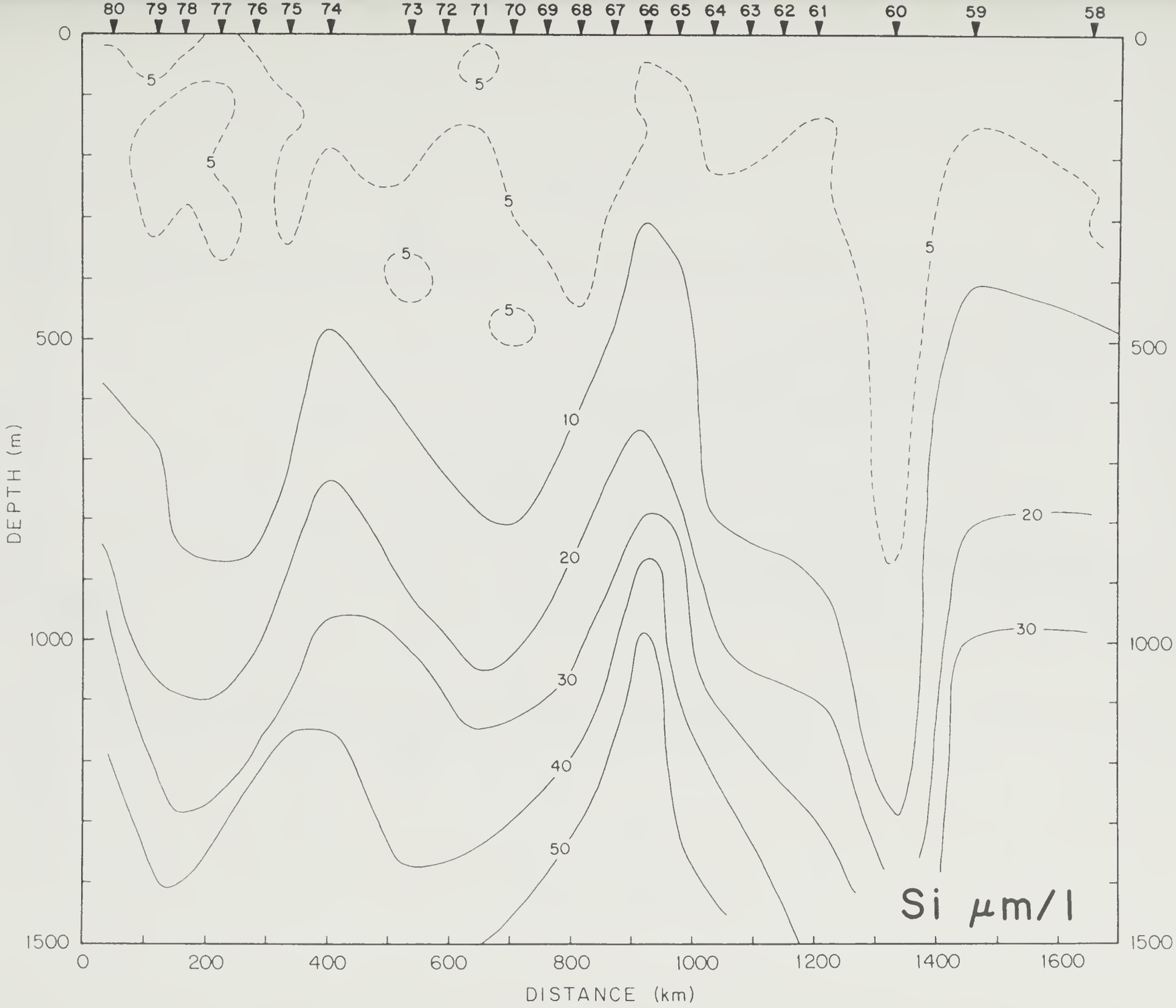
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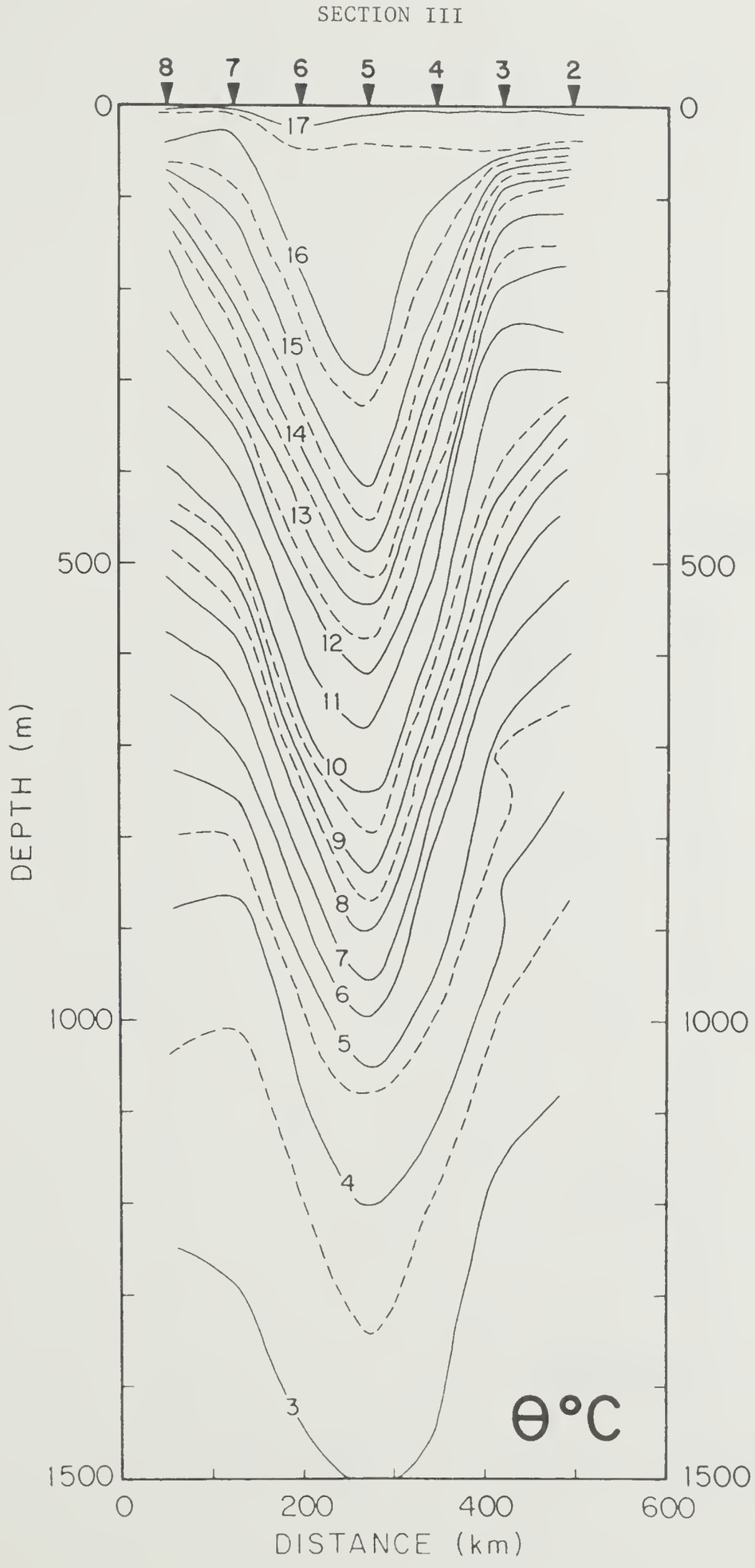
0
500
1000
1500
DEPTH (m)
5
10
20
30
40
50
Si µm/l
0 200 400 600 800 1000 1200 1400 1600
DISTANCE (km)

Fig. 11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14
13
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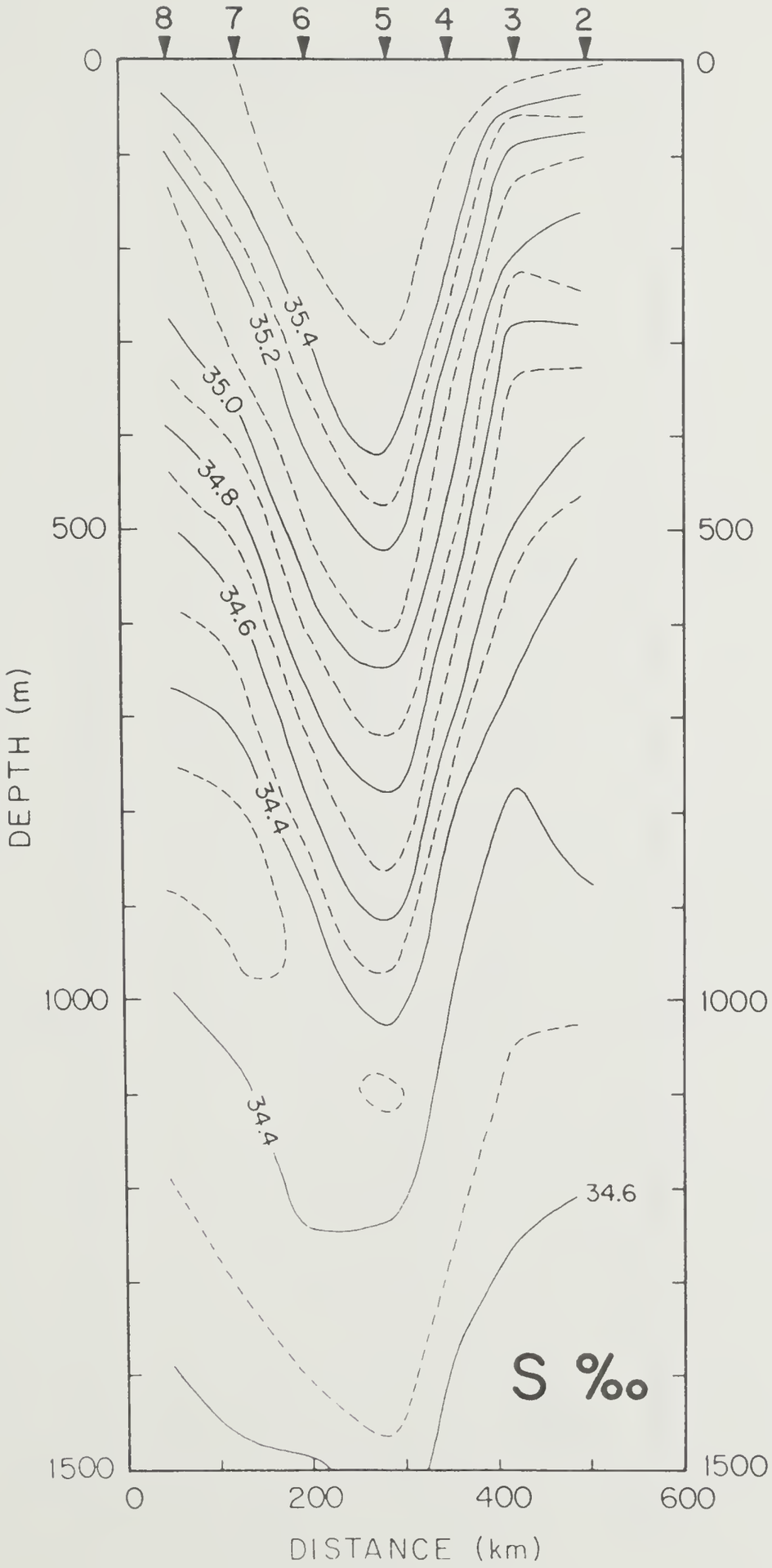
500
12
11
10
9
8
7
6
1000
1000
5
4
3
θ°C
1500
1500
DEPTH (m)
0
200
400
600
DISTANCE (km)

Fig. 12

SECTION III



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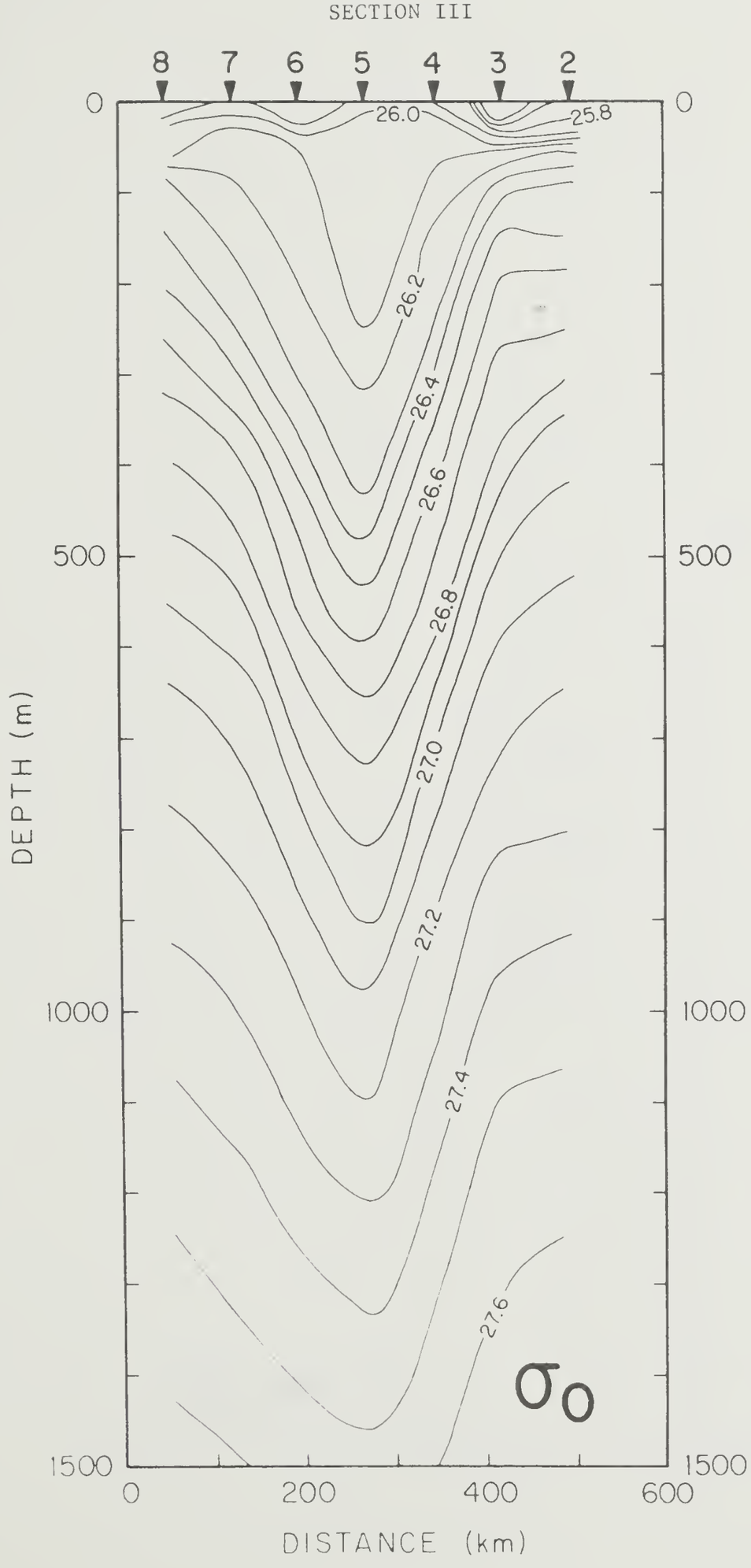
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27.4
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500
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1000
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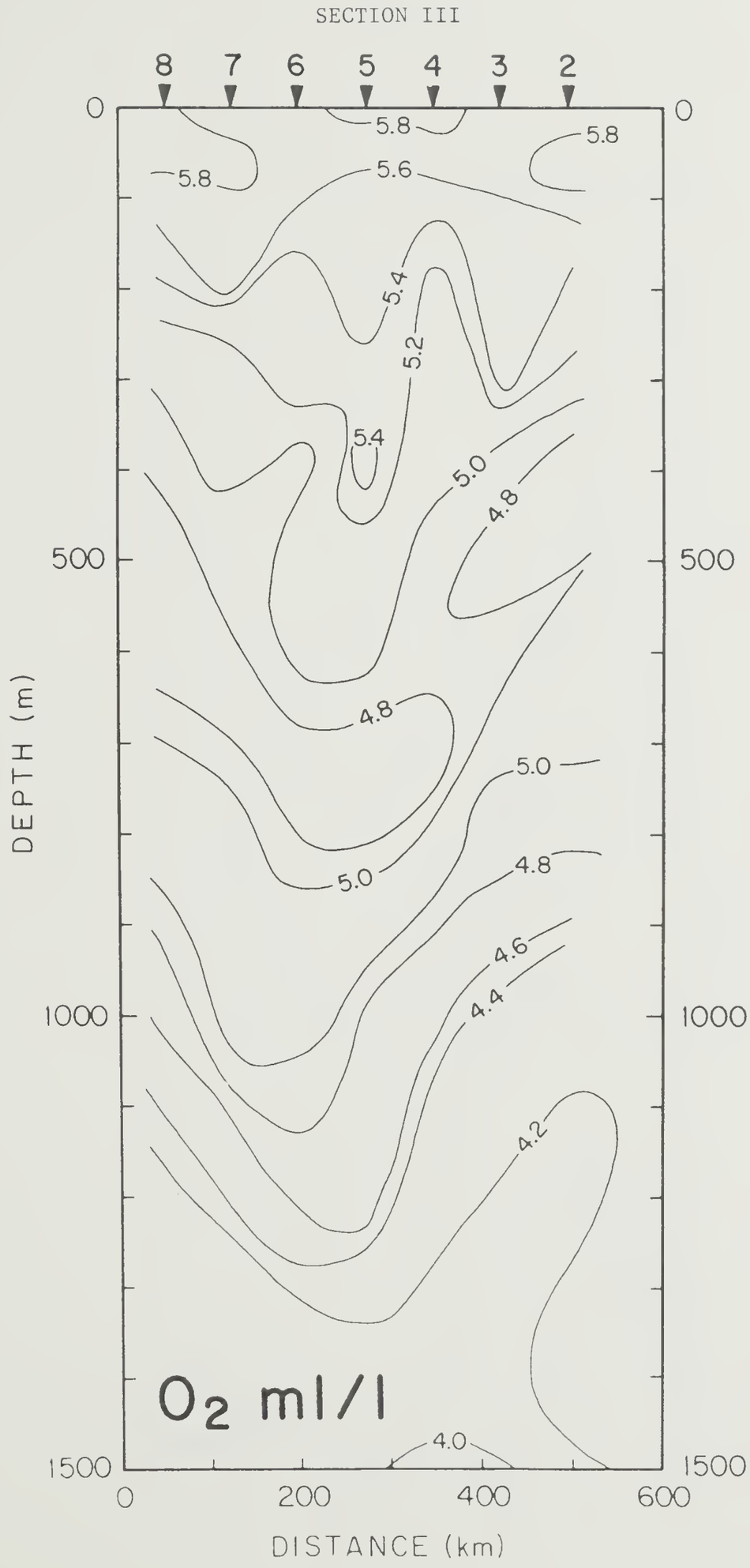
1500
DEPTH (m)
σ_0
0
200
400
600
DISTANCE (km)

Fig. 14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4.6
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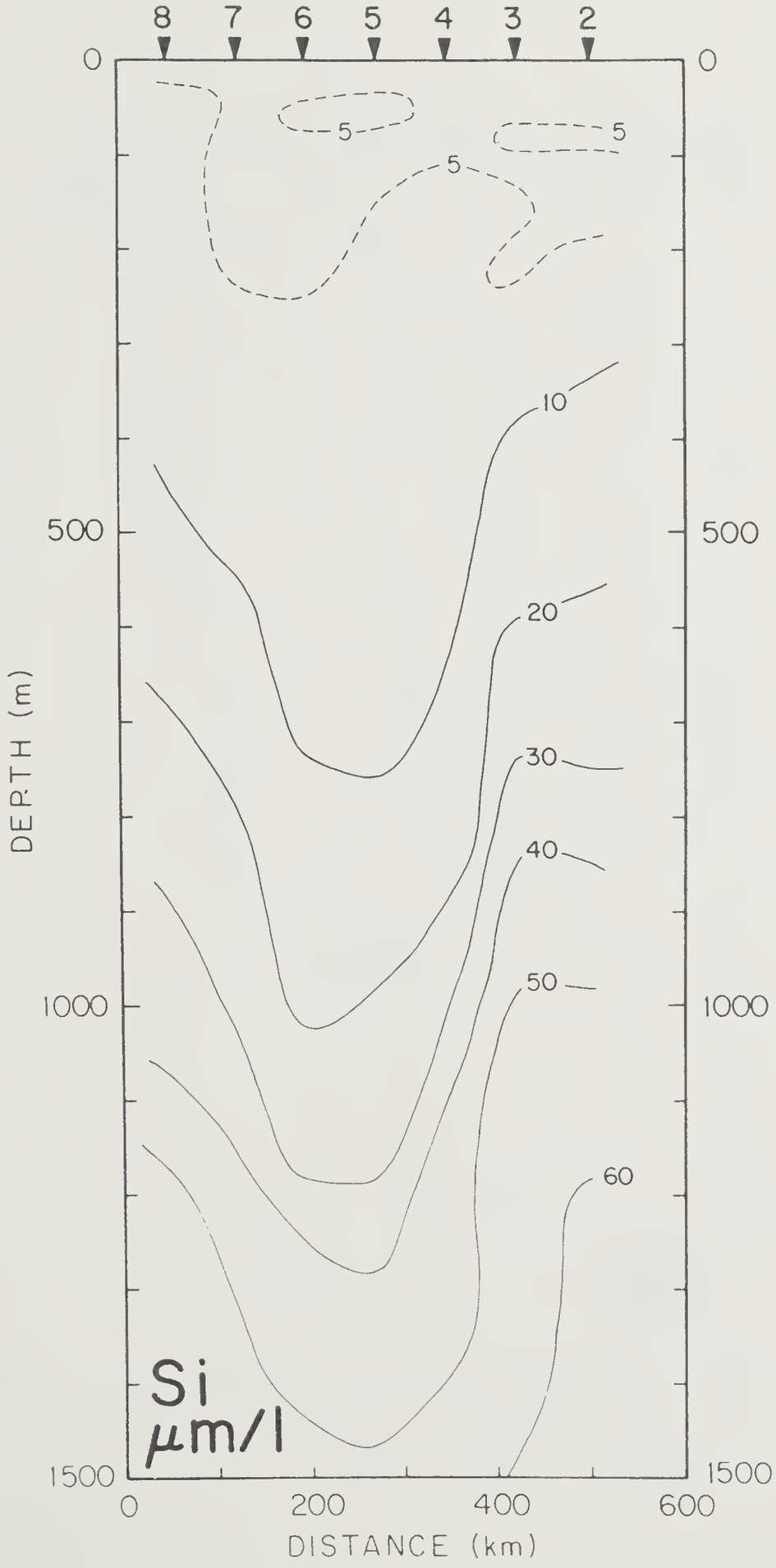
DISTANCE (km)
DEPTH (m)
O2 ml/l

Fig. 15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2
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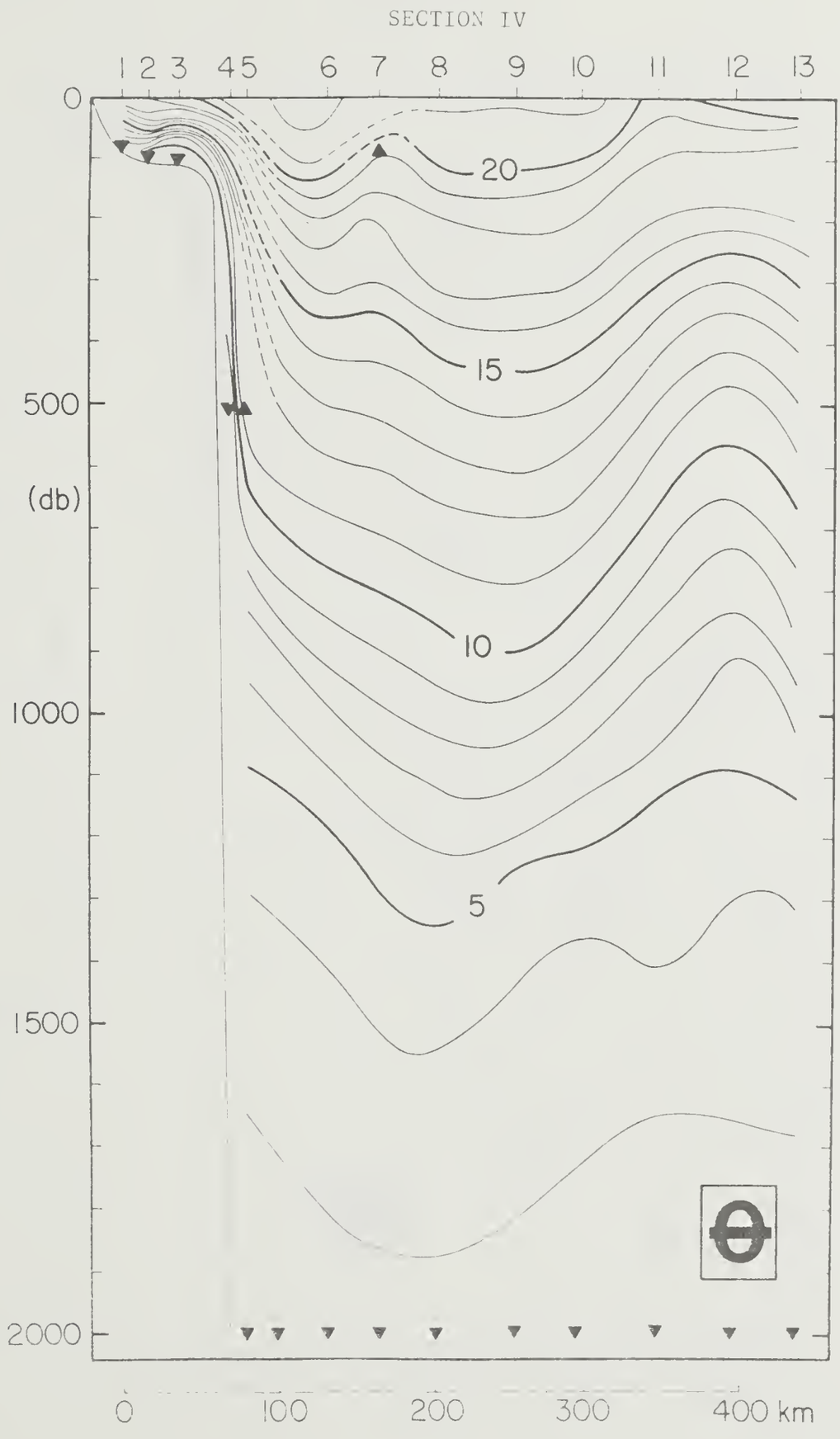
5
10
20
30
40
50
60
500
500
1000
1000
1500
1500
DEPTH (m)
Si
µm/l
0
200
400
600
DISTANCE (km)

Fig. 16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(db)
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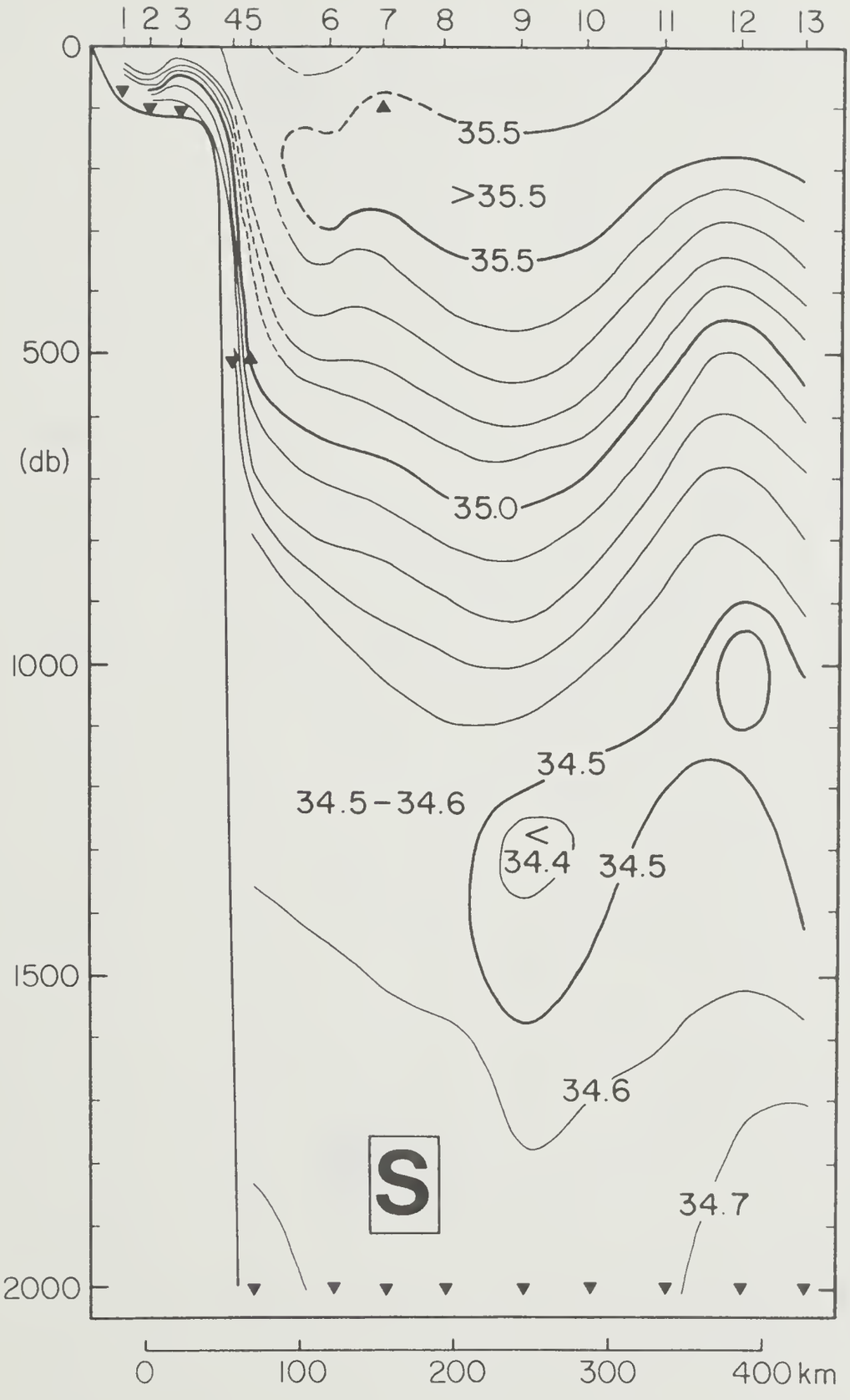
1500
2000
20
15
10
5
0 100 200 300 400 km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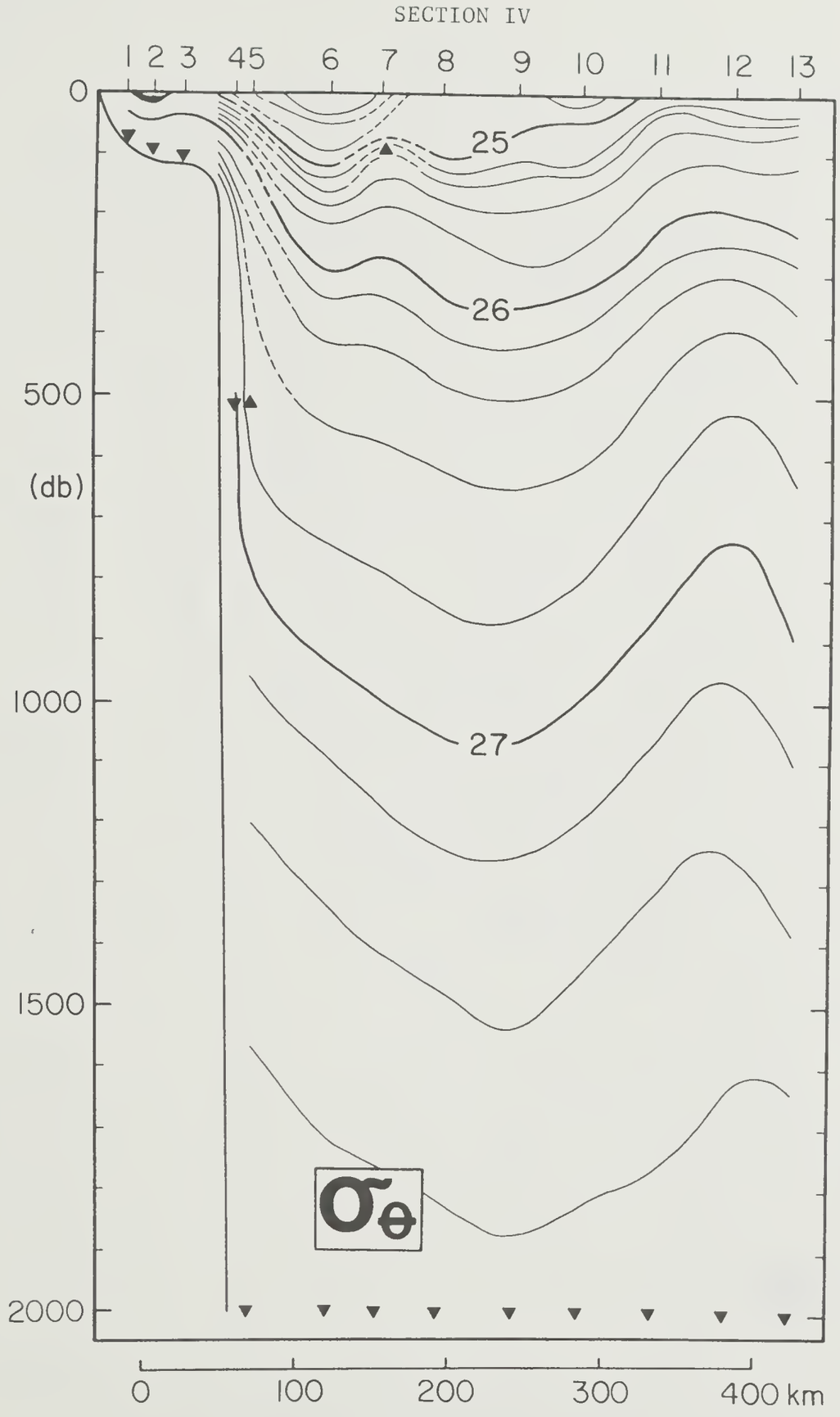
0
500
(db)
1000
1500
2000
35.5
>35.5
35.5
35.0
34.5
34.5-34.6
<
34.4
34.5
34.6
34.7
S
0
100
200
300
400 km

Fig. 18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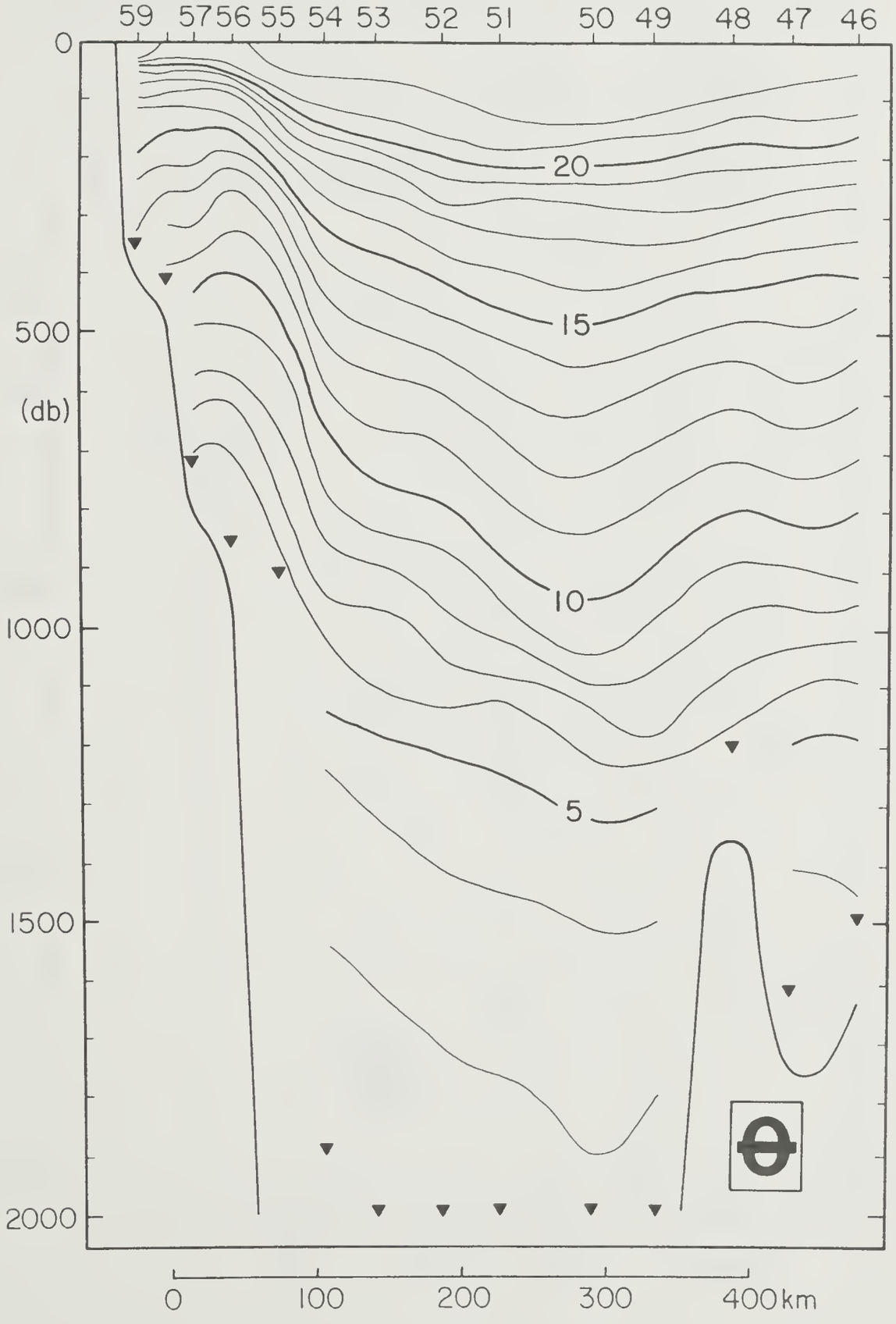
1 2 3 45 6 7 8 9 10 11 12 13
0
25
26
500
(db)
27
1000
1500
σ_θ
2000
0 100 200 300 400 km

Fig. 19

SECTION V



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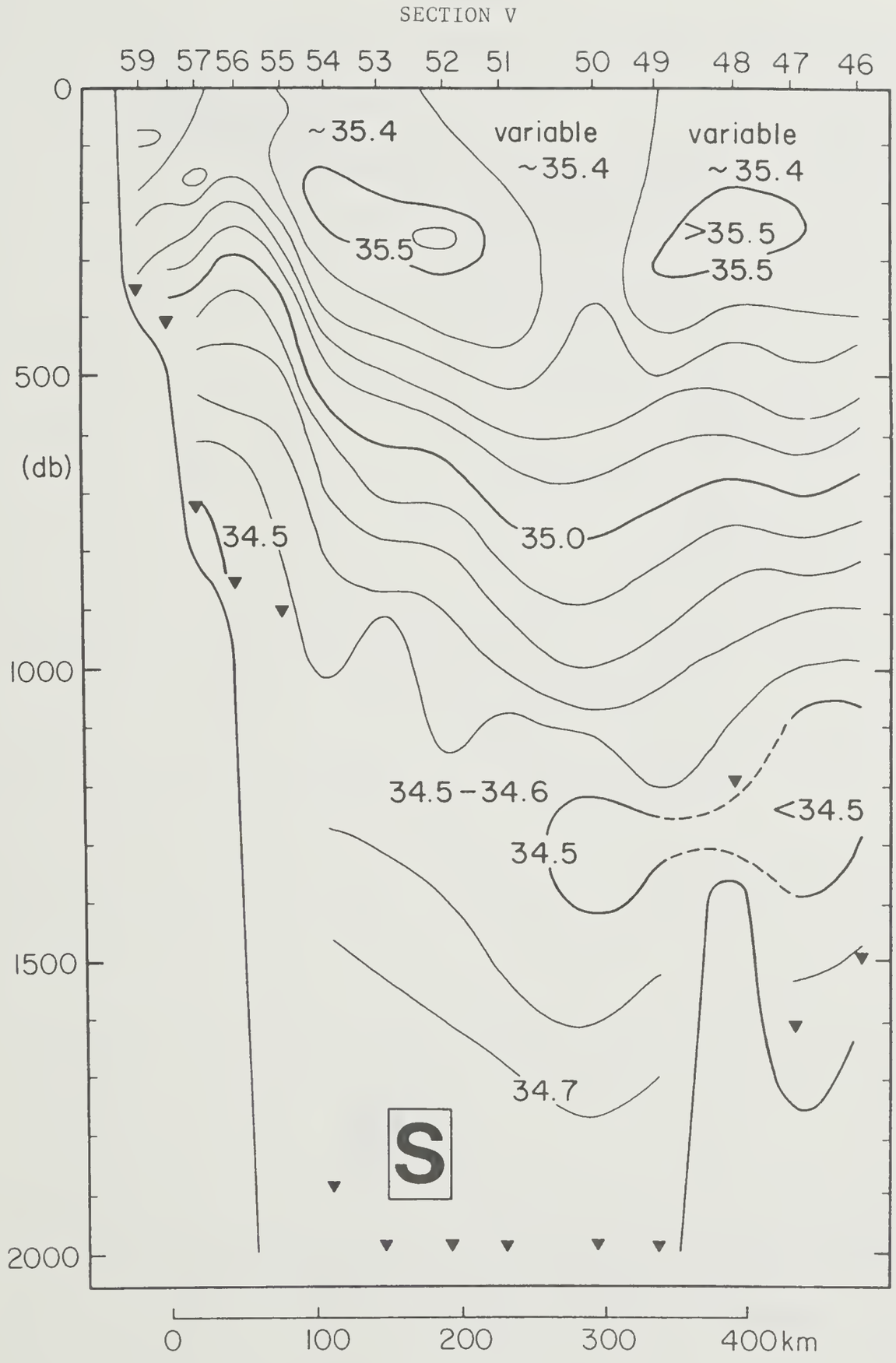
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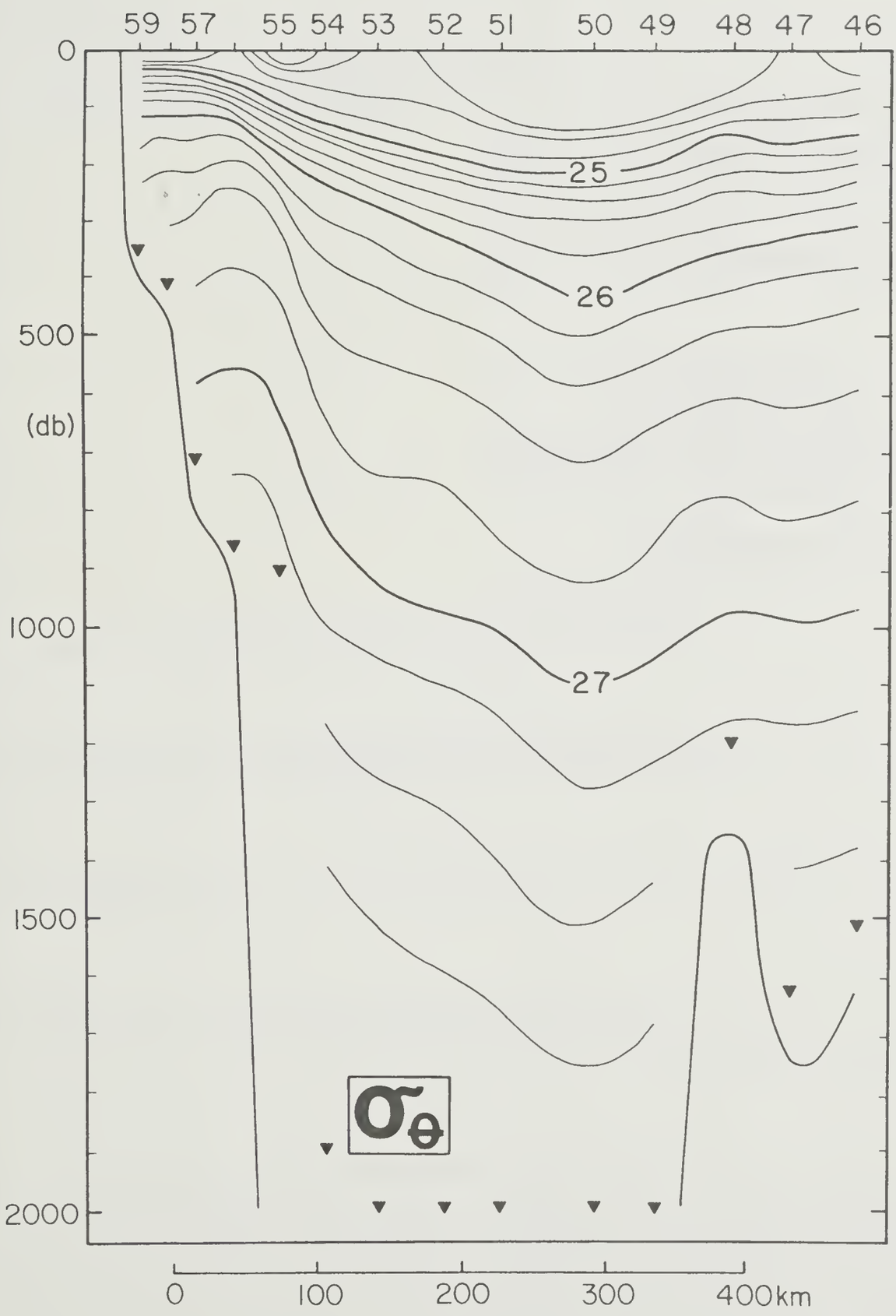
500
(db)
1000
1500
2000
~35.4
variable
~35.4
variable
~35.4
35.5
>35.5
35.5
34.5
35.0
34.5-34.6
<34.5
34.5
34.7
S
0
100
200
300
400km

Fig. 21


SECTION V
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0
500
(db)
1000
1500
2000
25
26
27
σ_θ
0 100 200 300 400km

Fig. 22

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Agulhas Retroflection Current, Southern Ocean, Hydrographic Sections

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Agulhas Retroflection, as observed in late 1983, consists of the main Retroflection at 21° E with two large warm core Agulhas rings to its west. The Retroflection position is situated at the eastern-most limit of its range. The ring immediately to the west (Retroflection Eddy) is elliptical in shape and carries 40 x 10^6 m^3/sec relative to the 1500 decibar (db) level; it's core properties are identical to the water enclosed by the Retroflection. These characteristics suggest that the Retroflection Eddy was formed just prior to the field work, thus the west edge of the Retroflection Eddy near 15° E marks the prior position of the main Retroflection, close to the western limit of its

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The Agulhas Current introduces Indian Ocean water masses into the Retroflection region, though this is limited to water less dense than sigma-0 of 27.5, shallower than 1500 or 2000 meters. At greater depth, the water flowing within the Retroflection circulation pattern consists primarily of Atlantic and circumpolar deep water. The Indian Ocean water entering the Retroflection is drawn from diverse sources: the thermocline of the South Indian subtropical gyre, the thermocline water

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